

## PATENT ABSTRACTS OF JAPAN

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(54) PEARLITIC RAIL EXCELLENT IN GAS PRESSURE WELDABILITY

(57)Abstract:

PROBLEM TO BE SOLVED: To prevent the occurrence of defects caused by the formation of a low-melting compound oxide (mullite) formed in the pressure weld interface at the time of gas pressure welding of a pearlitic rail and to obtain a sound gas pressure welded joint.

SOLUTION: This pearlitic rail has a composition consisting of, by weight, 0.60-1.20% C, 0.10-0.50% Si, 0.30-1.20% Mn, 0.0060-0.0200% N, and the balance iron with inevitable impurities or further containing one or  $\geq 2$  kinds among 0.05-2.00% Cr, 0.01-0.20% Mo, 0.05-1.00% Cu, 0.05-1.00% Ni, 0.005-0.05% Nb, 0.01-0.20% V, 0.1-2.0% Co, 0.005-0.05% Ti, and 0.0001-0.0050% B.

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## DETAILED DESCRIPTION

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[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the pearlite system rail for railroads mainly used as a longer rail by gas pressure welding.

[0002]

[Description of the Prior Art]In recent years, a flash plate bat, gas pressure welding, enclosed arc welding, thermite welding, etc. are among the welding processes to which long-welded-rail-ization according [ the rail for railroads ] to welding from simplification of orbital maintenance and check, control of noise and vibration, and a viewpoint of improvement in a degree of comfort is advanced and which are used.

[0003]In these welding processes, a flash plate bat and gas pressure welding are long-ization of the rail with indispensable art as shown also in literature (iron, steel, Vol.70, No.10-1984). In order to join rails in these junction, the junction nature tends to be influenced by a rail steel ingredient. In order to heat and join from a periphery with an oxygen-acetylene flame in the atmosphere, comparing the end face which should especially be joined by gas pressure welding, and pressurizing in adhesion \*\*\*\* and the direction of a rail shaft, There which an oxide generates to a joining interface, and it becomes a low melting point oxide of plural systems there depending on the case, and serves as a defect, In order to prevent oxidation, the way carry out the seal of the end face, and prevent invasion of oxygen, or a gasification element removes invasion oxygen etc. are examined so that JP,7-227684,A, JP,7-232285,A, etc. may see.

[0004]Although high carbon steel is used from the former as rail steel, In this case, the generated oxide being once returned during pressure welding by carbon in steel, and getting is stated to literature (the Japan Welding Society collected papers, the 14th volume, No. 2, 1996), and it is thought that carbon in steel is also contributed on a gas-pressure-welding

disposition.

[0005]However, the oxide of aluminum leading to low melting point multiple oxide generation has small generation energy, and since it is stable, it is presumed in the temperature region (-1300 \*\*) exposed by gas pressure welding that it is not easily returned with carbon.

[0006]

[Problem(s) to be Solved by the Invention]Rail steel is a structural member and is material to be secured [ strong ] on the characteristic. Therefore, it becomes indispensable alloy adding [ which are those reinforcing elements ] the case where add an alloy to iron and it is manufactured of Si, Mn, Cr, etc. at most. A compound oxide has the comparatively high melting point, these elements are independent, or since it is higher than the maximum heating temperature of gas-pressure-welding temperature, melting is not produced, but if the oxide of aluminum compounds with these, the aluminum-Si-Mn system oxide called the mullite in which the melting point is about 1100 \*\* will be formed, and it will become a cause of a defect.

[0007]In the deoxidation of rail steel, in order to prevent mixing of this aluminum as much as possible, methods other than aluminum killed, such as Si deoxidation, are used in many cases, but even in such a case, mixing of a little aluminum is inescapable and, as a result, may affect defective generating at the time of pressure welding. It is in the technical problem of this invention preventing oxidation of this minute amount mixing aluminum in a pressure welding interface, and preventing low melting point multiple oxide generation of plural systems.

[0008]

[Means for Solving the Problem]This invention is a pearlite system rail which prevents oxidation of minute amount aluminum in rail steel in a pressure welding interface at the time of gas pressure welding of a rail, and can prevent low melting point multiple oxide generation of plural systems, and the gist, (1) At weight %, it is C : 0.60 to 1.20%, Si : [ 0.10 to 0.50%, ] Mn: 0.30 to 1.20%, N : A pearlite system rail and (2) By weight %. [ excellent in gas-pressure-welding nature, wherein it contains 0.0060 to 0.0200% and the remainder consists of iron and inevitable impurities ] :0.60-1.20%, Si:0.10-0.50%, Mn : C 0.30 to 1.20%, Contain N:0.0060 to 0.0200%, and further Cr:0.05-2.00%, Mo: 0.01-0.20%, Cu:0.05-1.00%, nickel : 0.05 to 1.00%, Nb: 0.005 to 0.05%, V : 0.01 to 0.20%, Co : [ 0.1 to 2.0%, ] Ti: 0.005 to 0.05%, B : A pearlite system rail and (3) Gas-pressure-welding nature, [ excellent in gas-pressure-welding nature, wherein it contains 0.0001 to 0.0050% of a kind, or two sorts or more and the remainder consists of iron and inevitable impurities ] a pearlite system rail excellent in gas-pressure-welding nature the above (1) not producing a crack by low melting point oxide generation in a pressure welding interface at the time of gas pressure welding, or given in (2) -- it comes out.

[0009]

[Embodiment of the Invention]Hereafter, this invention is explained in detail. C, Si, and Mn are the \*\*\*\*\* elements for satisfying the intensity which should possess a rail and obtaining a

perlite system organization stably.

[0010]0.60% or more of content is required for C as an effective ingredient which makes perlite generate and secures \*\*\*\*\*. However, in the high content exceeding 1.20%, a cementite organization is deposited mostly and ductility falls remarkably. Therefore, the content of C may be 0.60 to 1.20%.

[0011]Si makes 0.10% or more contain as an ingredient effective in strengthening the ferrite in pearlite texture. However, the oxide formation at the time of gas pressure welding becomes easy, and the content exceeding 0.50% promotes multiple oxide formation with aluminum. Therefore, the content of Si may be 0.10 to 0.50%.

[0012]The effect of less than 0.30% of content is small by an element with Mn effective in strengthening of pearlite texture, like Si, the oxide formation at the time of gas pressure welding becomes easy, and the content exceeding 1.20% promotes multiple oxide formation with aluminum. Therefore, the content of Mn may be 0.30 to 1.20%.

[0013]About N, it is addition for preventing oxidation of minute amount aluminum in the steel made into the purpose of this invention, and minute amount aluminum in steel is specifically fixed in steel as a sludge of AlN, and it has the operation which prevents low melting point multiple oxide generation with oxides, such as the oxidation aluminum and Si and Mn, at the time of gas pressure welding.

[0014]Although Fe, Si, other selection elements Cr(ed) or mentioned later especially Nb, and V also have the possibility of generation as carbon nitride about nitride generation, the energy for generation is high as compared with aluminum, and generation of AlN arises selectively. And while at least 0.0060% of nitrogen is required, and the effect will decrease if it exceeds 0.0200% in order to fix as a nitride the quantity of aluminum which exists unescapable in steel, and about 0.004%, it becomes unstable on a steel ingot. Therefore, the content of N may be 0.0060 to 0.200%.

[0015]Hereafter, the element added if needed is explained. Although it is an element which Cr raises the balanced transformation point of perlite and makes pearlite texture detailed as a result, at less than 0.05%, the superfluous addition which is small as for the effect and exceeds 2.0% makes martensite generate, and embrittles steel. Therefore, the content of Cr may be 0.05 to 2.0%.

[0016]although it is an element which has an effect in improving strength, in less than 0.01% which is a lower limit, Mo reduces the effect, at more than 0.20% that is upper limit, causes generation of martensite and becomes harmful to the original surface-damage-proof nature of rail steel. Therefore, the content of Mo may be 0.01 to 0.20%.

[0017]Although Cu and nickel do not spoil ductility and toughness but it is an element effective in improvement in intensity, the effect decreases, and the effect will be saturated with less than 0.05% if it exceeds 1.00%. Therefore, the content of Cu and nickel may be 0.05 to 1.00%,

respectively.

[0018]although Nb and V are the improving strength elements by the deposit effect -- a lower limit -- at 0.005% and less than 0.01%, the effect decreases, respectively -- upper limit -- the effect will be saturated if it exceeds 0.05% and 0.20%, respectively. Therefore, the content of Nb makes content of V 0.01 to 0.20% 0.005 to 0.05%.

[0019]Although Co is an element effective in strengthening of perlite, an effect decreases, and an effect will be saturated with less than 0.1% if it exceeds 2.0%. Therefore, content of Co is set to 0.1-2.0.

[0020]Although Ti is made to contain 0.005% or more by an element effective also in grain refining of an organization in addition to the deposit effect, since the effect will be saturated if it is made to contain not much mostly, it makes a maximum 0.050%.

[0021]B promotes a pearlitic transformation, since it is effective in stabilization of pearlite texture, it is made to contain 0.00015 or more, but superfluous content makes the big and rough inclusion of a B system produce, and in order to degrade toughness, it makes a maximum 0.0050%.

[0022]It ingots with a converter and the usual fusion furnace of electric furnace \*\*\*\*, this molten steel is made into slab by ingot making and a cogging method, or a continuous casting process, and the rail steel which comprises above component composition is manufacture \*\*\*\*\* to a rail with the hot-rolling method further.

[0023]

[Example]An example shows this invention concretely below. The rail of the component composition shown in Table 1 was evaluated by performing gas pressure welding. The result was written together to Table 1. Here, evaluation of gas-pressure-welding nature produced the rail pressure welding joint on the gas-pressure-welding conditions described below, by the three point bending whose distance during two-point support is 1000 mm so that a head may serve as \*\*\*\*, carried out the forcible fracture of the joined part, and observed and evaluated existence of the defect by a low melting point oxide by viewing at the shape of the fracture surface.

[0024]

[Table 1]

	符号	C	Si	Mn	N	Al	その他	欠陥の有無
本発明例	A	0.68	0.15	0.80	0.0075	0.0040	Ti:0.01,B:0.0010	欠陥なし
	B	0.68	0.25	0.80	0.0180	0.0045		欠陥なし
	C	0.79	0.25	0.90	0.0100	0.0050	Cr:0.20	欠陥なし
	D	0.80	0.50	1.20	0.0080	0.0035	Nb:0.01,V:0.03	欠陥なし
	E	0.95	0.30	1.00	0.0080	0.0035	Mo:0.20,Co:0.50	欠陥なし
	F	0.79	0.25	1.00	0.0080	0.0035	Cu:0.3,Ni:0.3	欠陥なし
比較例	G	0.68	0.80	1.50	0.0040	0.0040		溶融欠陥有り
	H	0.78	0.80	1.30	0.0045	0.0035	Cr:0.8	溶融欠陥有り
	I	0.75	0.55	1.50	0.0250	0.0040	Mo:0.3	溶融欠陥有り

[0025]Gas pressure welding makes welding pressure 600 kgf(s)/mm<sup>2</sup> using the general-

purpose gas-pressure-welding machine called TGP-HA, Oxygen gas was performed by primary pressure  $7.0 \text{ kgf/cm}^2$ , 2nd order pressure  $5.0 \text{ kgf(s)/mm}^2$ , and flow  $115 \text{ l/min}$ , and acetylene gas was performed on condition of primary pressure  $1.3 \text{ kgf/cm}^2$ , 2nd order pressure  $0.6 \text{ kgf/cm}^2$ , and flow  $125 \text{ l/min}$ .

[0026]In Table 1, A-F is this invention rail and G-I is a comparison rail. About each sample offering rail, gas pressure welding was performed on the above conditions, the result of having evaluated the existence of defective generating of a gas pressure welding joint is as being shown in Table 1, and a defect was not accepted in this invention rail.

[0027]

[Effect of the Invention]By this invention, the pearlite system rail which defective generating of producing the crack by the low melting point oxide generation in a pressure welding interface does not produce can be provided at the time of gas pressure welding.

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CLAIMS

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[Claim(s)]

[Claim 1]At weight %, it is C. : 0.60 to 1.20%, Si:0.10-0.50%, Mn: 0.30 to 1.20%, N : A pearlite system rail excellent in gas-pressure-welding nature, wherein it contains 0.0060 to 0.0200% and the remainder consists of iron and inevitable impurities.

[Claim 2]At weight %, it is C. : 0.60 to 1.20%, Si : [ 0.10 to 0.50%, ] Mn: 0.30 to 1.20%, N : 0.0060 to 0.0200% is contained, Furthermore, Cr:0.05-2.00%, Mo:0.01-0.20%, Cu: 0.05-1.00%, nickel:0.05-1.00%, Nb : 0.005 to 0.05%, V : 0.01 to 0.20%, Co:0.1-2.0%, Ti:0.005-0.05%, and B : A pearlite system rail excellent in gas-pressure-welding nature, wherein it contains a kind of 0.0001 to 0.0050%\*\*, or two sorts or more and the remainder consists of iron and inevitable impurities.

[Claim 3]A pearlite system rail excellent in the gas-pressure-welding nature according to claim 1 or 2, wherein gas-pressure-welding nature does not produce a crack by low melting point oxide generation in a pressure welding interface at the time of gas pressure welding.

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